RELATION OF SEED WEIGHT TO VEGETATIVE GROWTH, DIFFERENTIATION, AND YIELD IN PLANTS

BY
STANLEY WILLIAM OEXEMANN
A.B., McKendree College, 1937
M.S., University of Illinois, 1939

AN ABSTRACT OF A THESIS
SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN
BOTANY IN THE GRADUATE SCHOOL OF
THE UNIVERSITY OF ILLINOIS, 1941

Urbana, Illinois
1941

RELATION OF SEED WEIGHT TO VEGETATIVE GROWTH, DIFFERENTIATION, AND YIELD IN PLANTS

BY
STANLEY WILLIAM OEXEMANN
A.B., McKendree College, 1937
M.S., University of Illinois, 1939

AN ABSTRACT OF A THESIS
SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN
BOTANY IN THE GRADUATE SCHOOL OF
THE UNIVERSITY OF ILLINOIS, 1941

Urbana, Illinois
1941

ACKNOWLEDGMENT

It is a pleasure to acknowledge grateful thanks to Professor Harry J. Fuller for displaying such profound interest in the experiments reported and for his many suggestions and criticisms that made possible the consumation of this work.

RELATION OF SEED WEIGHT TO VEGETATIVE GROWTH, DIFFERENTIATION, AND YIELD IN PLANTS

Introduction

The studies described in this paper were made to determine the relation of the initial dry weight of seeds to subsequent growth as measured in stem length, leaf areas, dry weight of roots and tops, number of leaves, number of buds, and number of flowers, to fruit and seed yield, and to tissue development in stems, leaves, roots, and petioles.

Factors, other than the initial weight of the seed, such as temperature, light, moisture and soil conditions were controlled and equalized as far as possible for each set of plants. In these experiments then the initial dry weight of the seed, minus the seed coat, was the only significant variable factor.

Experimental Methods and Materials

A. *Seeds and seed weights*

Seeds of each species or variety, soybeans, (*Soja max* Piper, var. Biloxi and Mandarin) ; cucumber (*Cucumis sativus,* L. var. Early White Spine) ; (*Lycopersicon esculentum,* Mill. var. Bonnie Best), were separated into three groups. Except for the tomato seeds, the seed coats were removed in all cases. The seeds were cut to produce greater variation in seed weight: the seeds of one group were left whole; approximately half of one cotyledon was removed from each seed in the second group; a whole cotyledon was removed from each seed in the third group. The seeds were then weighed accurately to one-tenth of a milligram. The cotyledons in the tomato, because of their small size, were cut after the seeds had germinated.

B. *Cultures*

The seeds and seedlings were planted in sterilized, well

mixed loam soil in 4½ inch pots, except that tomato and cucumber plants used for yield determinations were grown in 8 inch pots. Watering was done with sterile tap water until the epicotyls had appeared above the surface of the soil, after this unsterilized tap water was used. The plants were grown in the University of Illinois botany greenhouses.

C. *Dry weights*

Dry weights of plants or of plant structures were obtained by oven drying at 100°C. until there was no further loss in weight. Weights were made to one-tenth of a milligram.

D. *Measurements*

Leaf areas were determined from outlines on paper having thirty-six squares per square inch. The number of squares was determined by means of a calculator and the values converted into square centimeters.

Measurements of cross-sections of roots, stems, petioles, leaves, and their respective tissues were made from permanent mounts on slides by means of calibrated ocular micrometers.

E. *Correlation coefficients*:

Correlation coefficients were determined from the formula: $C = \frac{Sxy}{\sqrt{(Sx^2)\quad(Sy^2)}}$ in which C represents the correlation coefficient, x the deviations of the seed weights or, in the case of the tomato, the derivations of the seedling weights from the average, and y the deviations of the number of flowers, buds, leaves, fruits, and seeds, weights of various portions of the plants, growth rates, order of ripening of organs or fruits, or other growth criteria from their respective averages.

Results and Conclusions

There is a positive correlation between the initial seed weight and number, size, dry weight, and cross-sectional dimensions of vegetative organs at the end of the vegetative phase of the growth cycle. This indicates that there is a re-

lation between seed weight and the above criteria of growth.

The importance of the seed weight factor is greatest during the early stages of plant growth. In tomatoes, cucumbers, and soybeans, the plants grown from the lighter seeds have a slower initial growth rate which persists till about the end of the sixth week; thus there is a positive correlation for this period of growth. Beginning with the seventh week, and generally continuing to the end of the growth period, the growth rate for the plants grown from the lighter seeds exceeds that for the plants grown from the heavier seeds and thus the correlation values for this period are generally negative. Under favorable greenhouse conditions the early superiority of plants grown from heavier seeds over those grown from lighter seeds is generally lost by the time the plants reach maturity.

The relation between the percentage of storage tissue removed from seeds and early plant growth seems to be dependent on the natural weight of seeds and on the time and speed of the development of photosynthetic surface. In Biloxi soybeans which have relatively heavy seeds and a relatively early and proportionate development of photosynthetic surface, the effect on the growth rate of the removal of a certain percentage of storage tissue is relatively small. Mandarin soybeans have seeds of lighter weights and a smaller development of early photosynthetic surface; here the reduction of seed weight has a greater effect on the growth rate. -Cucumbers have seeds of relatively light weight and a relatively late development of true leaves; here the effect of the removal of a certain percentage of storage tissue on the early growth rate is still greater than in the Mandarin soybeans.

When tomatoes, cucumbers, and soybeans are grown under favorable greenhouse conditions, there is but little relation between seed weight and yield (numbers, sizes, and dry weights of fruits and seeds). No relationship was found between seed weight and order of fruit ripening in the tomato.

There is a reduction in cross-sectional areas of plant tissues (pith, xylem, and tissues outside the xylem) due to seeds of lighter weight. This reduction is more or less pro-

portional, except for the xylem and possibly the phloem, in both of which there is a greater degree of reduction in comparison with the other tissues.

There appears to be a relation between seed weight and number and size of vessel-like elements. There is also a relation between seed weight and vascular bundle size (length and width as seen in cross-section), but not between seed weight and vascular bundle number. Vascular bundle number varies with the species and thus seems to be a hereditary characteristic.

There is a higher mortality rate among seedlings grown from lighter weight seeds than among seedlings grown from heavier seeds. This difference in mortality rate is probably due to differences in plant vigor and disease susceptibility.

The time and speed with which plants mature are little affected by seed weight but are dependent upon hereditary factors and upon environmental factors which become operative after young plants have become well established.

VITA

Stanley William Oexemann was born March 4, 1912 at Nashville, Illinois.

He received his elementary education in the parochial and public schools of Washington County, Illinois and his secondary education through the American School, Chicago, Illinois, graduating in 1930.

In the fall of 1930 he entered McKendree College. Upon the completion of one year of college training he was granted a teacher's certificate and taught in the public schools of Washington County, Illinois for four years, 1931-1935. While teaching he furthered his education by attending summer school and by taking extension courses from the University of Missouri.

He was appointed teaching assistant in biology at McKendree College for the year 1935-36. Completing the requirements for the Bachelor of Arts degree during the summer of 1936, he was graduated from McKendree College June 1937.

During the years 1936-38, he again taught in the public schools of Washington County, Illinois.

He began his graduate study at the University of Illinois during the summer of 1937 where he received a Master of Science degree in June, 1939.

He held an assistantship in the Botany Department during the year 1939-40 and summer of 1940. For the year 1940-41 he held a fellowship in botany.

He is a member of Sigma Xi, Beta Pi Theta, Botanical Society of America, American Association for the Advancement of Science, and the Illinois Academy of Science.

He has published:

Relation of the effects of growth-promoting substances to photosynthetic activity, the mass law of growth, and seed germination. Trans. Ill. State Acad. Sci. 33:84-86 (1940).

Digitized by the Internet Archive
in 2026

https://archive.org/details/IA41549818_0050